AUGMENTED WEAR TECHNOLOGY

PROJECT REPORT

Submitted by

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DECLARATION

We,the undersigned, hereby declare that the project report **"Augmented Wear Technology"**, submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under the coordination of **Mr. Anoop P V, Assistant Professor**. This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources. we also declare that we have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in our submission. we understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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CERTIFICATE

This is to certify that the report entitled **"Augmented Wear Technology"** submitted by **Anu A, Arjun K, Philip Raj, Athul Devin A K** to APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering is a bonafide record of the project work carried out by them under my/our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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ABSTRACT

Augmented wear is a wearable gestural interface that augments the physical world around us with digital information and lets us use natural hand gestures to interact with that information. Every one of us is aware of the five basic senses - seeing, feeling, smelling, tasting and hearing. These senses have evolved through millions of years. Whenever we encounter a new object/experience our natural senses tries to analyse that experience and the information that is obtained is used to modify our interaction with the environment. But in this new age of technologies the most important information that helps one to make right decision is something that cannot be perceived and analysed by our natural senses. That information is the data in the digital form, and it is available to everyone through sources like internet. The augmented wear technology concept is an effort to connect this data in the digital world in to the real world.

The augmented wear technology contains a pocket projector, a computing device and a camera contained in a pendant-like, wearable device and a mobile computing device preferably android device. Both the projector the camera and sensors are connected to a coding device (in our case-a raspberry pi 3B+) present in the augmented wear device and it is connected to mobile computing device present in the user's pocket. The projector projects visual information enabling surfaces, walls and physical objects around us to be used as interfaces; while the camera recognizes and tracks user's hand gestures and physical objects using computer-vision based techniques. The software program processes the video stream data captured by the camera and tracks the locations of the colored markers (visual tracking fiducials) at the tips of the user's fingers. The movements and arrangements of these fiducials are interpreted into gestures that act as interaction instructions for the projected application interfaces. The augmented wear technology prototype is used to implement several applications that have shown the usefulness, viability and flexibility of the system.

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ABBREVIATIONS

AWT	Augmented Wear Technology
RPi	Raspberry pi 3B+
TUIO	Tangible User Interface Objects
OSC	Open Sound Control
AR	Augmented Reality
WiFi	Wireless Fidelity
DLP	Digital Light Processing

CHAPTER 1

INTRODUCTION

We've evolved over millions of years to sense the world around us. When we encounter something, someone or some place, we use our five natural senses which includes eye, ear, nose, tongue mind and body to perceive information about it; that information helps us make decisions and choose the right actions to take. But arguably the most useful information that can help us make the right decision is not naturally perceivable with our five senses, namely the data, information and knowledge that mankind has accumulated about everything and which is increasingly all available online.

Although the miniaturization of computing devices allows us to carry computers in our pockets, keeping us continually connected to the digital world, there is no link between our digital devices and our interactions with the physical world. Information is confined traditionally on paper or digitally on a screen. ‘Augmented Wear Technology’ bridges this gap, bringing intangible, digital information out into the tangible world, and allowing us to interact with this information via natural hand gestures. ‘Augmented Wear Technology’ frees information from its confines by seamlessly integrating it with reality, and thus making the entire world your computer.

‘Augmented Wear Technology’, it is the newest jargon that has proclaimed its presence in the technical arena. This technology has emerged, which has its relation to the power of these six senses. Our ordinary computers will soon be able to sense the different feelings accumulated in the surroundings and it is all a gift of the ‘Augmented Wear Technology’ newly introduced.

Right now, we use our “devices” (computers, mobile phones, tablets, etc.) to go into the internet and get information that we want. With ‘Augmented wear technology’ we will use a device no bigger than current cell phones and probably eventually as small as a button on our shirts to bring the internet to us in order to interact with our world! ‘Augmented wear technology’ will allow us to interact with our world like never before.

CHAPTER 2

LITERATURE REVIEW

The literature survey is done by focusing on improving technology used and efficiency various augmented reality devices. Compared to other survey papers in the field, our objective is to provide a more thorough study about different techniques used in projected augmented reality. This paper also presents a comprehensive survey on different projected augmented reality methods.

2.1 THE SIXTH SENSE

The sixth sense[1], it's a wearable interface that augments the physical world around us with the digital information. It's just born concept which allows user to connect with the internet seamlessly. Without use of keyboard, mouse we can see videos access, change, move data simply. But this concept bottle necks lead to modification of the same by using commands instead of gestures. Speech IC is used as a database for commands which will be initially trained for storage. It performs the corresponding commands accessing the operation from the mobile device connected to it and action is projected using a projector over any surface. It's more possibly to be implemented in future because of its cost constraints.[2]

2.2 GOOGLE GLASS

Dynamic Most of the general population who have seen the glasses[3], however, may not be permitted talking openly; a noteworthy component of the glasses was the area data. Google will have the capacity to catch pictures of its PCs and enlarged reality data comes back to the individual wearing them through the camera effectively inherent on the glasses. For the minute, if a man taking a gander at a point of interest then he could see verifiable and nitty-gritty data. Likewise remarks about it that their companion's cleared out. In the event that its facial acknowledgment programming ends up direct and sufficiently exact, the glasses could remind a wearer and furthermore discloses to us when and how he met the foggy recognizable individual remaining before him at a capacity or gathering. A PC which is scene based worked straightforwardly through your eyes instead of your pocket or pocket. A skilled innovation for a wide range of Handicapped/crippled individuals.

Google Glass [4] is a wearable PC with a head-mounted show (HMD) that is being created by Google in the Project Glass innovative work project, with the mission of delivering a massadvertise omnipresent PC. The edges don't presently have fitted focal points, Google is on the way toward considering sunglass retailers association, for example, Ray-Ban or Warby Parker, wish to open a retail shop to attempt on the gadget for clients. Individuals who wear solution glasses can't utilize traveler version, yet Google has affirmed that Glass will be perfect with casings and focal points as indicated by the wearer's medicine and potentially append able to ordinary remedy glasses. Google X Lab built up this Glass, which has involvement with other modern innovations, for example, driverless autos.

2.3 LIGHT FORM

Light Form [5], based in San Francisco, aims to turn the technology into something anyone can use. The device is designed to work with existing projectors and comes with software that is as easy to use as Photoshop.

The size of the projection depends on the projector. "You could do your coffee mug using a tiny pico projector or you could do the side of a building using a really big projector." says Lightform's design director Phil Reyneri. The camera periodically rescans the scene and recalibrates projections if things have moved, making it suitable for long-term installations, and you can control or modify the graphics through an app. The whole package will cost more than a depth sensor like Microsoft's Kinect but less than a mid-range laptop when it starts shipping.

The mapping is not quite real-time - it takes about a minute to do a scan and you can't interact with the projected images, unlike with some systems that use haptic devices or motion tracking to give users the illusion of touching what they see. A projected AR prototype by Texas-based Argo Design, for example, uses computer vision to allow people to play air hockey using real objects as bats to hit a virtual puck, with the pitch markings projected onto a tabletop - though it only works on a flat surface.

2.4 DESKTOPOGRAPHY

Desktopography [6], The technology has been developed by researchers from Carnegie Mellon University’s Future Interfaces Group, in Pennsylvania.It is a relatively small augmented reality projector that can beam a fully interactive display onto virtually any surface.

The system, which the researchers have taken to calling Desktopography, combines a computer, depth sensor, and projector into a single unit. It's small enough that it can be plugged into a light socket, and the current prototype of the hardware is actually really impressive. It includes a custom camera-equipped overhead projector that can beam an interactive smartphone interface onto almost any surface. The projector itself is self-contained and screws into a standard light-bulb fitting, so is essentially as easy to install as a light-bulb.

Table 2.1: **Comparison study**

No.	Research works	Technology	Advantages	Limitations
1	Sixth sense	• Gesture movement • Virtual keypad • Image recognition	• Devices is portable • Multitouch and Multi user interaction • Low cost • Mind mapping	• Size of the device • Compatibility issues
2	Google glass	• Virtual Reality • Android System • EyeTap • Wearable Computers. • Glass OS	• User convenience • It shows even emails through voice commands • There are multiple methods used and it is easy to capture pictures and record audios.	• Google glass cannot be used every people who have the defect in their eyes. • Google glass cannot be used while driving • Google glass can be easily broken as it is more sensible

3	Lightform	• projection mapping • Depth sensing	• It handles all the calculations, and can even fine-tune its alignment when objects move	• Should be stationary both device and surface.
4	Desktopography	• Projected augmented reality • Gesture recognition	• Desktopography can be used on non-flat surfaces, and apps can be moved around individually. • Support most of the desktop apps	• These systems are not designed for the variety and complexity of actual work surfaces, which are often in flux and cluttered with physical objects.

2.5 PROBLEM DEFINITION

The major problems identified while reviewing the areas related to AWT. Major challenges identified:

- Gesture recognition
- Smart devices (resource-limited)
- Heterogeneous surfaces
- Recognition Failures
- Energy consumption
- Stability of projection
- Precision of touches

We need an efficient mechanism to handle & provide coordination of sensors to reduce errors & improve quality of projection mapping

CHAPTER 3

SOFTWARE REQUIREMENTS SPECIFICATION

3.1 INTRODUCTION

The purpose of this document is to present a detailed description of the Augmented wear technology. It will explain the purpose and features of the system, the interfaces of the system, what the system will do, the constraints under which it must operate and how the system will react to external stimuli. This document is intended for both the stakeholders and the developers of the system.

3.1.1 Purpose

The intention of augmented wear technology is to make the power of perception seemingly independent of the five senses which are hearing, touch, smell, sight and taste. That is to make the reception of information apart from the five senses. This also means Extra Sensory Perception (ESP). Challenge is what people like and change is what they want. To make a device which has power of perception will be the new change in technology and being successful in such task will be a great challenge. Using this definition engineers tried to develop an interface to receive the information from the surroundings and interact with people. Since the objective of the device was to receive the human interaction and use the device's own sense to analyze the interaction and give the results, it was named as augmented wear technology device. The reason for development of this kind of device is to compel the technology to adapt peoples environment. People would then be able to stand up from the chair in front of the computer monitor and would enjoy the real world at the same time interacting with the digital device using it as their extra sense.

The Software Requirements Specification (SRS) will provide a detailed description of the requirements for the Augmented Wear Technology (AWT). This SRS will allow for a complete understanding of what is to be expected of the AWT to be constructed. The clear understanding of the AWT and its' functionality will allow for the correct software to be developed for the end user and will be used for the development of the future stages of the project. This SRS will provide the foundation for the project. From this SRS, the AWT can be designed, constructed, and finally tested.

This SRS will be used by the software engineers constructing the AWT and the end users. The software engineers will use the SRS to fully understand the expectations of this AWT to construct the appropriate software. The end users will be able to use this SRS as a “test” to see if the software engineers will be constructing the system to their expectations. If it is not to their expectations the end users can specify how it is not to their liking and the software engineers will change the SRS to fit the end users’ needs.

3.1.2 Scope

The software product to be produced is an Augmented Wear Technology which will augment the physical world around us with digital information and lets us use natural hand gestures to interact with that information. The first subsystem is a projection system to augment physical world. The second subsystem is the gesture recognition system which recognises end user gestures. The third subsystem is the software interface system which is interacting with the user through the combination of first and second subsystem. These three subsystems’ functionality will be described in detail in section 2-Overall Description. Every one of us is aware of the five basic senses - seeing, feeling, smelling, tasting and hearing. These senses have evolved through millions of years. Whenever we encounter a new object/experience our natural senses tries to analyse that experience and the information that is obtained is used to modify our interaction with the environment. But in this new age of technology the most important information that helps one to make right decision is something that cannot be perceived and analysed by our natural senses. That information is the data in the digital form, and it is available to everyone through sources like the internet. The augmented wear technology concept is an effort to connect this data in the digital world into the real world.

3.1.3 Overview

The augmented wear technology comprises a pocket projector, a RPi and a camera contained in a pendant like, wearable device. The projector connected to a mobile computing device and the camera is connected to RPi. The projector projects visual information enabling surfaces, walls and physical objects around us to be used as interfaces; while the camera recognizes and tracks the user's hand gestures and physical objects using computer vision based techniques. The software program processes the video stream data captured by the camera and tracks the locations of the colored markers at the tip of the user's fingers. The movements and arrangements of these fiducially are interpreted into gestures that act as interaction instructions for the projected application interfaces. Augmented wear technology supports multi-touch and multi-user interaction.

3.2 THE OVERALL DESCRIPTION

Augmented wear technology is a wearable gestural interface that enhances the physical world around us with digital information and lets us use natural hand gestures to interact with that information. It is based on the concepts of augmented reality and has well implemented the perceptions of it.Augmented wear technology has integrated the real world objects with digital world. The fabulous Augmented wear technology is a blend of many exquisite technologies. The thing which makes it magnificent is the marvelous integration of all those technologies and presents it into a single portable and economical product. It associates technologies like hand gesture recognition, image capturing, processing, and manipulation, etc. It superimposes the digital world on the real world.

Augmented wear technology is a perception of augmented reality concept. Like senses enable us to perceive information about the environment in different ways it also aims at perceiving information. Augmented wear is in fact, about comprehending information more than our available senses. And today there is not just this physical world from where we get information but also the digital world which has become a part of our life. This digital world is now as important to us as this physical world. And with the internet the digital world can be expanded many times the physical world. God hasn't given us sense to interact with the digital world so we have created them like smart phones, tablets, computers, laptops, net books, PDAs, music players, and others gadgets. These gadgets enable us to communicate with the digital world around us.

But we're humans and our physical body isn't meant for digital world so we can't interact directly to the digital world. For instance we press keys to dial a number; we type text to search it and so on. This means for an individual to communicate with the digital world he/she must learn it. We don't communicate directly and efficiently to the digital world as we do with the real world. The Augmented wear technology is all about interacting to the digital world in most efficient and direct way. Hence, it wouldn't be wrong to conclude augmented wear technology as gateway between digital and real world. Before AWT came there were other methods like speech recognition software, touch recognition etc., which empowered us with direct interfacing.

3.2.1 Product Perspective

The AWT is an independent stand-alone system. It is totally self contained.It contains a pocket projector, an RPi and a camera contained in a pendant-like, wearable device. Both the projector the camera and sensors are connected to a coding device (in our case-an RPi). The projector projects visual information enabling surfaces, walls and physical objects around us to be used as interfaces; while the camera recognizes and tracks users' hand gestures and physical objects using computer-vision based techniques. The software program processes the video stream data captured by the camera and tracks the locations of the colored markers at the tip of the user's fingers. The movements and arrangements of these fiducials are interpreted into gestures that act as interaction instructions for the projected application interfaces.

3.2.2 Hardware Specification

The AWT contains a pocket projector, an RPi and a camera contained in a pendant-like, wearable device. Both the projector the camera and sensors are connected to a coding device (in our case-a RPi).

Processor :Raspberry pi 3b+

- **CPU:**1.4GHz 64-bit quad-core ARM Cort ex-A53 CPU
- **RAM:**1GB LPDDR2 SDRAM
- **WiFi:**Dual-band 802.11ac wireless LAN (2.4GHz and 5GHz) and Bluetooth 4.0
- **Power:**5V/2.5A DC power input
- **Operating system support:**Linux

Projector :DLP micro projector

- **Image System:**DLP
- **Brightness:**30 Ansi lumens
- **Contrast:**800:1
- **Max support:**1080P
- **Aspect Ratio:**4:3/16:9
- **Power Input:**5V-2A
- **Power Consumption:**10W(Max)
- **Projection Dist:**0.3-4M
- **Size:**46x47x48 mm
- **Net Weight:**0.2 kg

Camera :Raspberry PI 5 MP camera

- **Dimensions:**25mm x 20mm x 9mm
- 5 MP resolution
- 2592 x 1944 pixel static images
- 1080p30 video

Coding device :Android smart phone

- **Operating System:**Android v5.1 + (Lolipop)
- **Display:**5.0 inches (12.7 cm) display
- **Processor:**arm64 v8a
- **Ram:**2 GB Ram
- **Battery:**3000 mAh battery

Power Bank :Mi 10000mAH Li-Polymer Power Bank

- **Item Weight:**240 g
- **Product Dimensions:**7.1 x 1.4 x 14.7 cm
- **Battery Capacity:**10000 mAh
- **Battery Cell:**Composition Lithium Polymer
- **Cable Type:**MicroUSB

3.2.3 Software Specification

The software program processes the video stream data captured by the camera and tracks the locations of the colored markers (visual tracking fiducials) at the tip of the user's fingers. The movements and arrangements of these fiducials are interpreted into gestures that act as interaction instructions for the projected application interfaces.

Operating system : Raspbian OS (Linux)

Language : Python 3.6

Frameworks : Open CV, Kivy, TUIO

3.3 SPECIFIC REQUIREMENTS

This section contains all the software requirements at a level of detail, that when combined with the system context diagram, use cases, and use case descriptions, is sufficient to enable designers to design a system to satisfy those requirements, and testers to test that the system satisfies those requirements.

3.3.1 External Interfaces

The Augmented Wear Technology will use the following:

- Projector
- Camera
- RPi
- Color Marker
- Android Device

User Interfaces

The User Interface Screens are described in table 3.1.

Table 3.1: **Augmented Wear User Interface Screens**

Screen Name.	Description
Time	Shows world time.
Gallery	For viewing images.
Paint	For drawing .
Calculator	For performing simple calculations.
Instant photo capture	Capture moments on simple gesture.

Software Interfaces

The system shall interface with Python program.

Hardware Interfaces

The system shall run on a Linux based system.

Communication Interfaces

The system shall be a standalone product that does require internet communication interfaces.

3.3.2 Functional Requirements

Functional requirements define the fundamental actions that system must perform. The functional requirements for the system are divided into three main categories, projection, gesture recognition, software interface.

1. Projection
   1.1. The system shall project.
   1.2. The system should stabilize dynamically.
   1.3. The system should consume low energy.
   1.4. The system should be lightweight.
   1.5. The system should display accurate colours.

1.6. The system should maintain resolution.

1.7. The system should maintain large screen ratio.

2. Gesture management

2.1. The system should recognize predefined gestures.

2.2. The system should identify colour bands.

2.3. The system should maintain high stability.

2.4. The system should be faster in recognition.

3. Software interface

3.1. The system should be consistent, no ambiguity.

3.2. The system should be simple.

3.3. The system should be clear.

3.4. The system should be concise.

3.5. The system should be intuitive.

3.6. The system should be responsive.

3.7. The system should be flexible.

3.3.3 Nonfunctional Requirements

Nonfunctional Requirements define system attributes such as security, reliability, performance, maintainability, scalability, and usability. They serve as constraints or restrictions on the design of the system across the different backlogs.

Performance Requirements

Performance requirements define acceptable response times for system functionality.

- The load time for user interface screens shall take no longer than five seconds.
- The gestures should be recognized in two seconds.
- The projection should stabilize in two seconds.

Design Constraints

The Augmented Wear Technology shall be a stand-alone system running in a Linux environment. The system shall be developed using Python. The overall cost of the system should not exceed 10,000. The system should be have wearable pendant like structure. Weigh no more than 300 grams.

Standards Compliance

There shall be consistency in variable names within the system. The graphical user interface shall have a consistent look and feel.

Availability

The system shall be available at all times.

Maintainability

The Augmented Wear Technology is being developed in python. Python is a dynamic programming language and shall be easy to maintain.

Portability

The Augmented Wear Technology shall run in any Linux environment that contains Python Environment. The system should be portable with battery operated.

CHAPTER 4

METHODOLOGY

4.1 FRAMEWORKS

4.1.1 Open CV

OpenCV [7](Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 18 million. The library is used extensively in companies, research groups and by governmental bodies.

Along with well-established companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota that employ the library, there are many startups such as Applied Minds, VideoSurf, and Zeitera, that make extensive use of OpenCV. OpenCV's deployed uses span the range from stitching streetview images together, detecting intrusions in surveillance video in Israel, monitoring mine equipment in China, helping robots navigate and pick up objects at Willow Garage, detection of swimming pool drowning accidents in Europe, running interactive art in Spain and New York, checking runways for debris in Turkey, inspecting labels on products in factories around the world on to rapid face detection in Japan.

It has C++, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS. OpenCV leans mostly towards real-time vision applications and takes advantage of MMX and SSE instructions when available. A full-featured CUDAand OpenCL interfaces are being actively developed right now. There are over 500 algorithms and about 10 times as many functions that compose or support those algorithms. OpenCV is written natively in C++ and has a templated interface that works seamlessly with STL containers.

4.1.2 Kivy app development framework

Kivy [8] is a free and open source Python library for developing mobile apps and other multitouch application software with a natural user interface (NUI). It is distributed under the terms of the MIT License, and can run on Android, iOS, Linux, OS X, and Windows. Kivy is the main framework developed by the Kivy organization, alongside Python for Android, Kivy iOS, and several other libraries meant to be used on all platforms. In 2012, Kivy also supports the Raspberry Pi which was funded through Bountysource. The framework contains all the elements for building an application such as:

- Extensive input support for mouse, keyboard, TUIO, and OS-specific multitouch events.
- A graphic library using only OpenGL ES 2, and based on Vertex Buffer Object and shaders.
- A wide range of widgets that support multitouch.
- An intermediate language (Kv) used to easily design custom widgets.

4.1.3 TUIO

TUIO [9] is an open framework that defines a common protocol and API for multi touch surfaces. The TUIO protocol allows the transmission of an abstract description of interactive surfaces, including touch events and tangible object states. This protocol encodes control data from a tracker application (e.g. based on computer vision) and sends it to any client application that is capable of decoding the protocol. There exists a growing number of TUIO enabled tracker applications and TUIO client libraries for various programming environments, as well as applications that support the protocol. This combination of TUIO trackers, protocol and client implementations allows the rapid development of table based tangible multi touch interfaces. TUIO has been mainly designed as an abstraction for interactive surfaces, but also has been used in many other related application areas. Technically TUIO is based on Open Sound Control - an emerging standard for interactive environments not only limited to musical instrument control - and can be therefore easily implemented on any platform that supports OSC. Since the initial publication of the TUIO protocol specification to the public domain as part of the Reactable synthesizer, after its first implementation within reacTIVision, the protocol has been also adopted by several other projects related to tangible and multitouch interaction, such as the NUI Group and several other tangible interaction platforms. Due to its widespread adoption since, the TUIO protocol and API can be considered a community standard, to which this web site provides the principal information repository, such as the actual protocol specification, the TUIO client API definition and many other resources that may be necessary or useful for the development of TUIO based interactive applications.

4.2 HARDWARES

The hardware components are coupled in a pendant like mobile wearable device. The components are:

1. Camera
2. Projector
3. Mobile computing device (Raspberry pi 3B+)
4. Color markers
5. Coding device (Android smartphone)
6. Power Bank

4.2.1 Camera

Camera captures an object in view and tracks the user's hand gestures. It sends the data to a mobile computing device.Camera recognizes and tracks user’s hand gestures and physical objects using computer-vision based techniques. Augmented wear technology implements a gestural camera that takes photos of the scene the user is looking at by detecting the ‘framing’ gesture. It acts as a digital eye, connecting you to the world of digital information.

Figure 4.1: **Pi camera module**

4.2.2 Projector

A tiny DLP projector displays data sent from the coding device on any surface in view-object, wall, or person. The projector projects visual information enabling surfaces, walls and physical objects around us to be used as interfaces. We want this thing to merge with the physical world in a real physical sense. The projector itself contains a battery inside, with 30 minutes of battery life.

Figure 4.2: **DLP Projector**

4.2.3 Mobile computing device (Raspberry Pi 3B+)

The system uses a mobile computing device present inside augmented wear device as the processing device which process the input from the camera for gestures. Raspberry pi 3B+ is used as the mobile computing device. The camera and DLP projector are connected to the Raspberry pi 3B+. The software program enabling some features of the system runs on this computing device. The android device inside the users pocket runs the graphical user interface. The camera, the projector are connected to Raspberry pi 3B+ using wired connection. The raspberry pi 3B+ connected to smartphone using wireless connection. The raspberry pi 3B+ in the Augmented wear device processes the video data, using vision algorithms to identify the gestures.

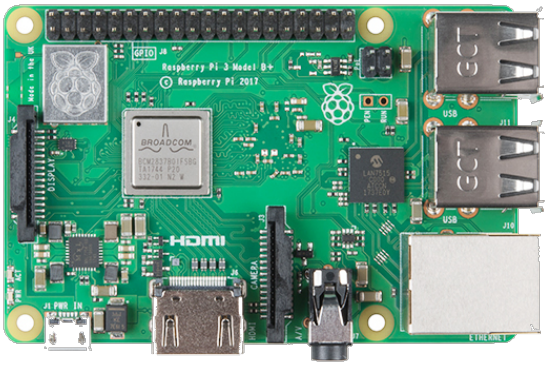

Figure 4.3: **Raspberry Pi 3B+**

4.2.4 Color marker

Color marker is at the tip of the user's fingers. Marking the user's fingers with red, green, and blue tape helps the webcam recognize gestures. The camera tracks the movements of the color markers. The movements and arrangements of these makers are interpreted into gestures that act as interaction instructions for the projected application interfaces. The software program processes the video stream data captured by the camera and tracks the locations of the colored markers (visual tracking fiducials) at the tip of the user's fingers using simple computer-vision techniques. The movements and arrangements of these fiducials are interpreted into gestures that act as interaction instructions for the projected application interfaces. The maximum number of tracked fingers is only constrained by the number of unique fiducials, thus AWT also supports multi-touch and multi-user interaction.

Figure 4.4: **Color markers**

4.2.5 Android device

The system uses android device for rendering graphical user interface. The application run on android device is based on kivy app development framework. The Rpi sends coordinates to android device the software running on android device converts this points into mouse clicks and perform user actions. The output is displayed in projector.

4.2.6 Power bank

The power bank used here is of 10000 mAh capacity.It is the powerhouse of the system.It provides necessary power for Rpi and projector. A 5 Volt 2 Ampere output for Rpi and 5 Volt 1 Ampere output for projector device.It has a stand-by time of 3 hours.

Figure 4.5: **10000 mAh power bank**

4.3 Applications

The AWT prototype implements several applications that demonstrate the usefulness, viability and flexibility of the system. The AWT has a huge number of applications. The following are the few applications developed for AWT.

- Take pictures
- Drawing application
- Calculator
- Check the time
- View multimedia contents
- Zooming features
- Developer info

4.3.1 Camera

Here you can capture photos using your fingers. When the camera application is opened the gesture recognition system will look for the three coloured markers concurrently. When it happens it captures the photo and is saved to the gallery. It reduces the need for carrying an additional camera and it helps to capture photos instantly

Figure 4.6: **Camera app**

4.3.2 Clock

It is not necessary to buy watches anymore to see the time. Users do not have to take their phone out from the pocket either. Using clock application of AWT device, in order to check the time you just need to select clock app to get a virtual watch. ItâĂŹs like a real analog watch. There is no extra buttons that may affect the clock experience you can go back from clock app by simply tapping on any of the clock handles, which acts as a back button.

Figure 4.7: **Clock app**

4.3.3 Calculator

The Augmented wear device projects a keypad into your palm or any uniform surface. We can use this virtual keypad to perform simple mathematical operations. A simple calculator is big help you can use calculator whenever you want. You can simply project to anywhere even to the restaurant bills to calculate tips. All the basic operations including addition,multiplication,subtraction and division are supported by this calculator.It is also capable of performing floating point operations.

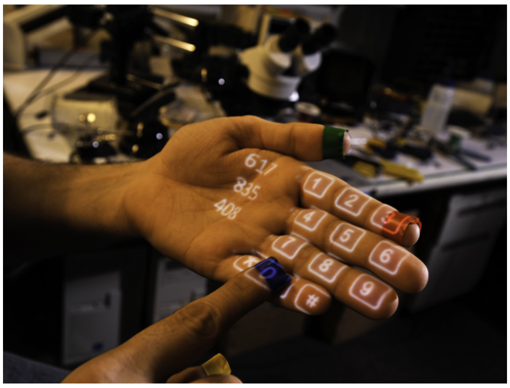

Figure 4.8: **Calculator app**

4.3.4 Paint

Now, color pens and papers or any wide device is not necessary for drawing picture. Using this small portable device one can let out his artistic talent anywhere on any surface. Understanding the gesture of the colored fingertip of the user, this application draws the image and projects it on the surface. Draw a picture on any desired surface just by moving the index finger in the air. The paint app act like a black board. It supports monochrome activities only.It transforms any surface into a drawing table. You can scribble your ideas anywhere anytime. An undo option is also available in case of errors.

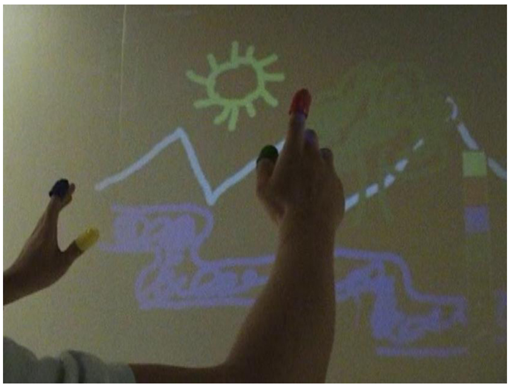

Figure 4.9: **Paint app**

4.3.5 Gallery

The gallery is where you can find the photos you captured.Gallery is organised as albums. When we choose one album all the pictures in that album are arranged in a scattered format. We can project them onto any surface, and use gestures to sort through the photos, and organize and resize them. The user can zoom in or zoom out and rotate using intuitive hand movements.

Figure 4.10: **Gallery app**

4.4 Working

4.4.1 Initialization

When power is on, the system needs to be initialized and environment variables needs to be set. The system functions as three separate modules. The first module is Rpi and pi cam. An Open CV program is running on Rpi . During initialization we need to set frame coordinates of projection manually. For cropping out region of interest from each frame to recognise markers. After this process we need to set HSV threshold values of each color markers.

To facilitate camera feature we need to establish a connection with kivy application.In order to do that we need to setup a socket server.Raspberry pi act as socket server and kivy application acts as socket client.Python has built in support for socket protocol.

To communicate mouse pointer information from raspberry pi to kivy application we need a fast and reliable protocol for that kivy supports a protocol called TUIO.TUIO is used for creating a custom input device.Kivy application acts as TUIO server which has built in support.TUIO client is implemented on raspberry pi application.TUIO client in raspberry pi send mouse pointer information to kivy application as OSC(Open sound control protocol) packets which is the underlying protocol of TUIO.

The second module is kivy app running on android device.This is connected to raspberry pi using wi-fi connection.Initializing kivy app involves three steps.

- Here we initialize socket client in kivy application for facilitating camera feature and TUIO server for receiving mouse pointer information.

- To display user interface using projector user needs to connect android device and projector manually.The projector has a driver software in android.User manually needs to connect to projector using miracast and enable screen sharing.

- After initializing and connecting to projector the kivy application need to render graphical user interface.

The third module is a DLP projector which is connected to android device using miracast through wifi.The projector projects user interface inside cameras frame area.

4.4.2 Gesture recocgnition

Gesture recognition involves sequence of steps.At first raspberry pi takes a frame of image from picam and crop it according to coordinates of projection, this will reduce false detection outside the region of interest.Before recognising markers the system need to perform a series of preprocessing operations that are.

- The image from picam is in BGR format, it needs to be converted to HSV format which will increase the detection rate.

- Apply threshold of first marker into the image frame that is, output select a certain pixels which having HSV value between threshold values of marker.

- The threshold image is converted to mask image which is in binary format,to accomplish this we put '0' in case of no pixel and '1' in case of pixel.

- Apply contour detection on mask image and select the largest contour which meets certain radius value.

- The centroid of contour is selected as centre of marker.

We send this mouse coordinates as TUIO packets,it contains two type of instructions

```
/tuio/2Dcur alive s_id0 ... s_idN
/tuio/2Dcur set s_id x_pos y_pos x_vel y_vel m_accel
```

A typical TUIO bundle will contain an initial ALIVE message, followed by an arbitrary number of SET messages that can fit into the actual bundle capacity and a concluding FSEQ message. A minimal TUIO bundle needs to contain at least the compulsory ALIVE and FSEQ messages. The FSEQ frame ID is incremented for each delivered bundle, while redundant bundles can be marked using the frame sequence ID -1.

4.4.3 Processing in android device

The application in android device rece ives series of TUIO packets.The TUIO implementation in kivy receives all these packets and preprocess it.To create virtual mouse pointer movements. On the basis of user interaction the updated user interface is rendered.The newly rendered user interface is sent to projector for displaying.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 INTRODUCTION

AWT is an user friendly interface which integrates digital information into the physical world and its objects, making the entire world your computer.It does not change human habits but causes computer and other machines to adapt to human needs.AWT uses hand gestures to interact with digital information and Supports multi-touch and multi-user interaction .The device could be used by anyone without even a basic knowledge of a keyboard or mouse and also It is portable and easy to carry as we can wear it in our neck. AWT has the potential of becoming the ultimate "transparent" user interface for accessing information about everything around us

5.2 OUTCOME

AWT use interface design

1. Main menu

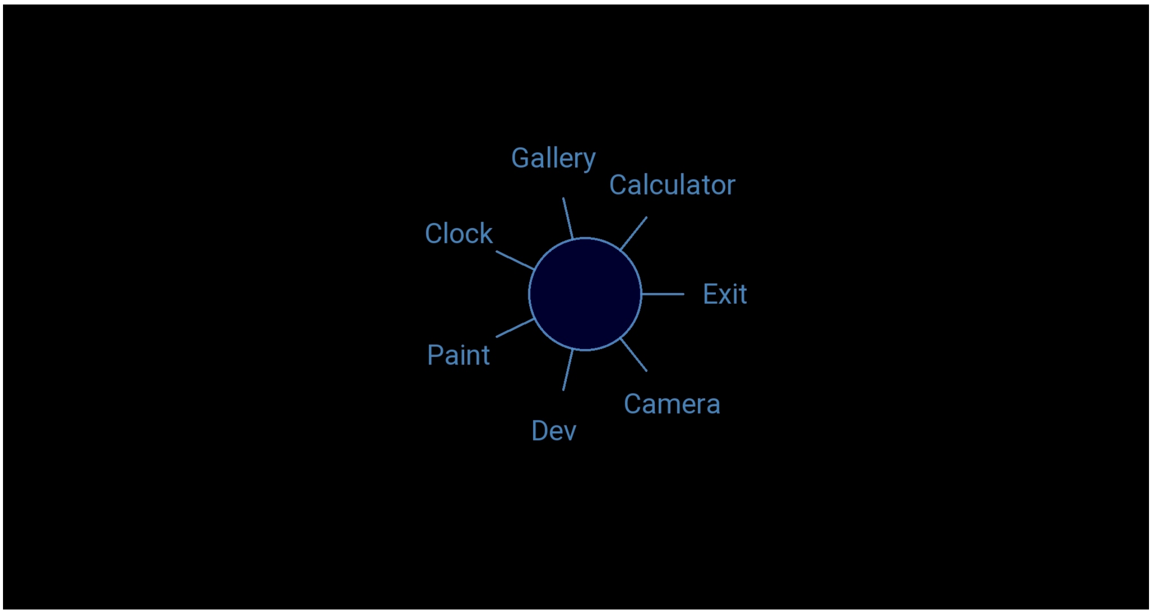

Figure 5.1: **Main menu of AWT**

2. Clock

   All we have to do is show the marker to get a virtual watch that gives us the correct time. The computer tracks the marker, recognizes the gesture, and instructs the projector to flash the image of a watch onto his wrist.

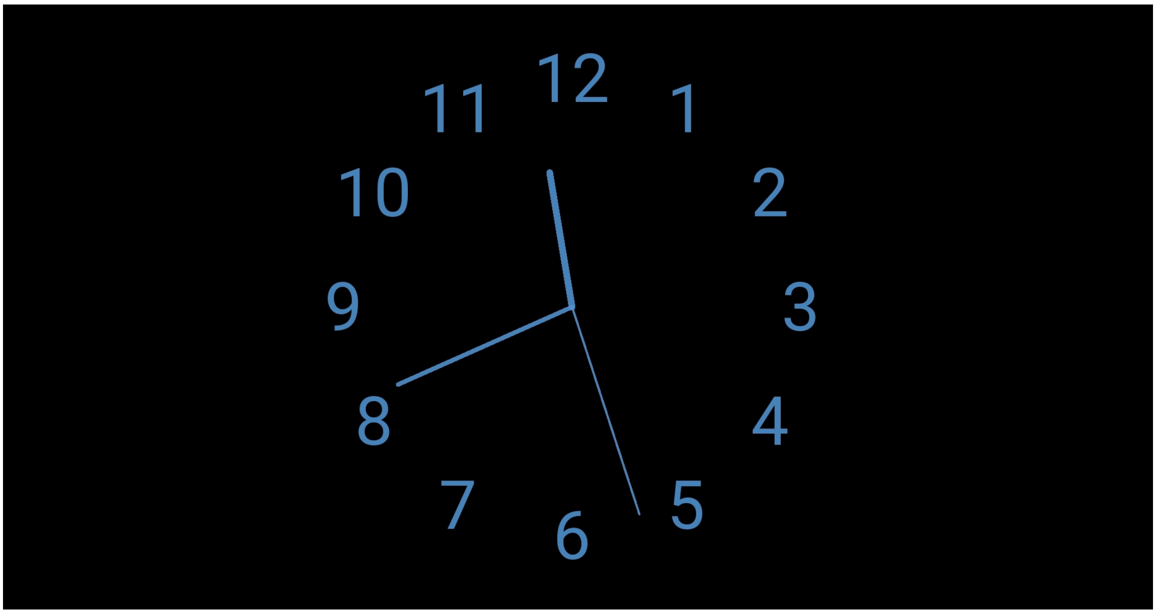

Figure 5.2: **Clock of AWT**

3. Calculator

   AWT projects a calculator onto your hand, then use that virtual calculator to make a calculation. Calculating two numbers also will not be a great task with the introduction of Augmented wear technology. Just enter the number with your palm acting as the virtual keypad. The keys will come up on the fingers.

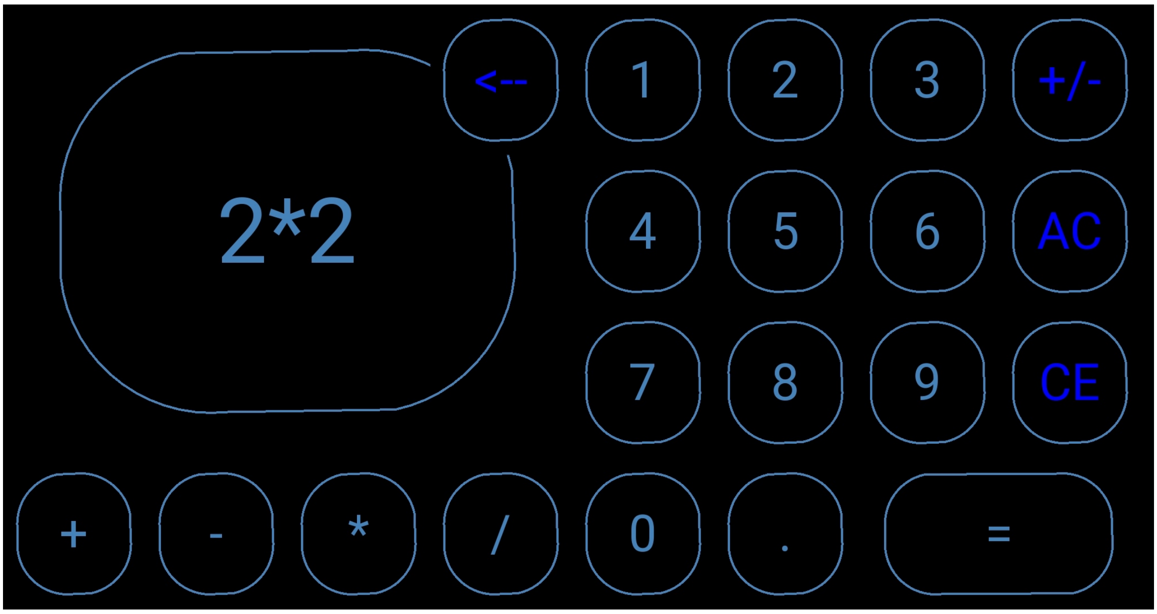

Figure 5.3: **Calculator of AWT**

4. Gallery

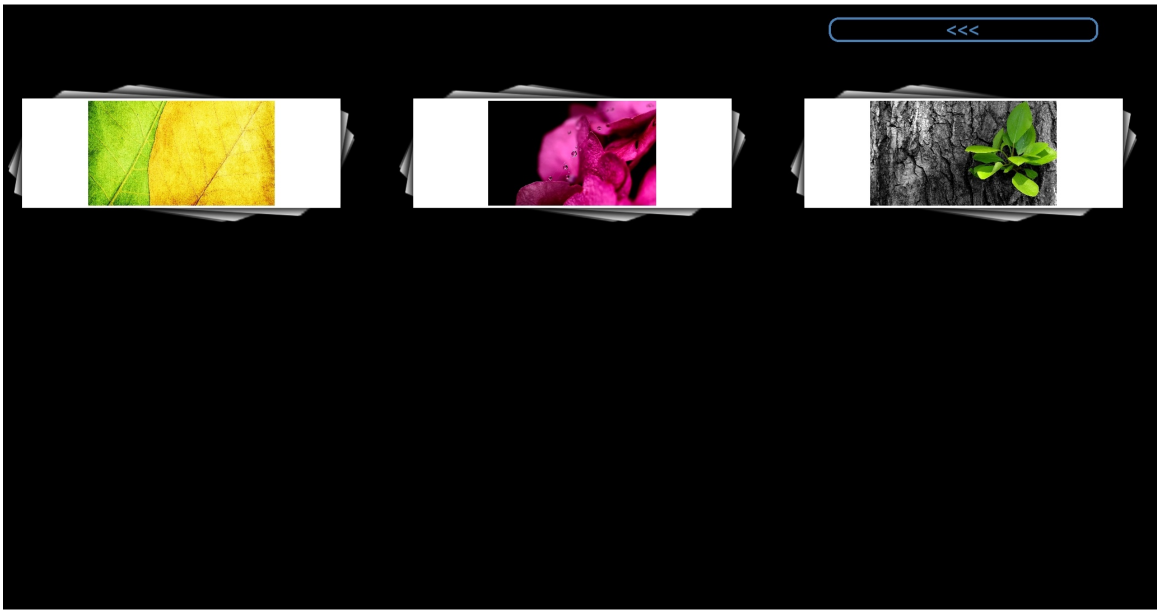

Figure 5.4: **Gallery app album view of AWT**

Figure 5.5: **Gallery view of AWT**

5. Paint

The print application lets the user draw on any surface by tracking the fingertip movements of the userâĂŹs index finger.

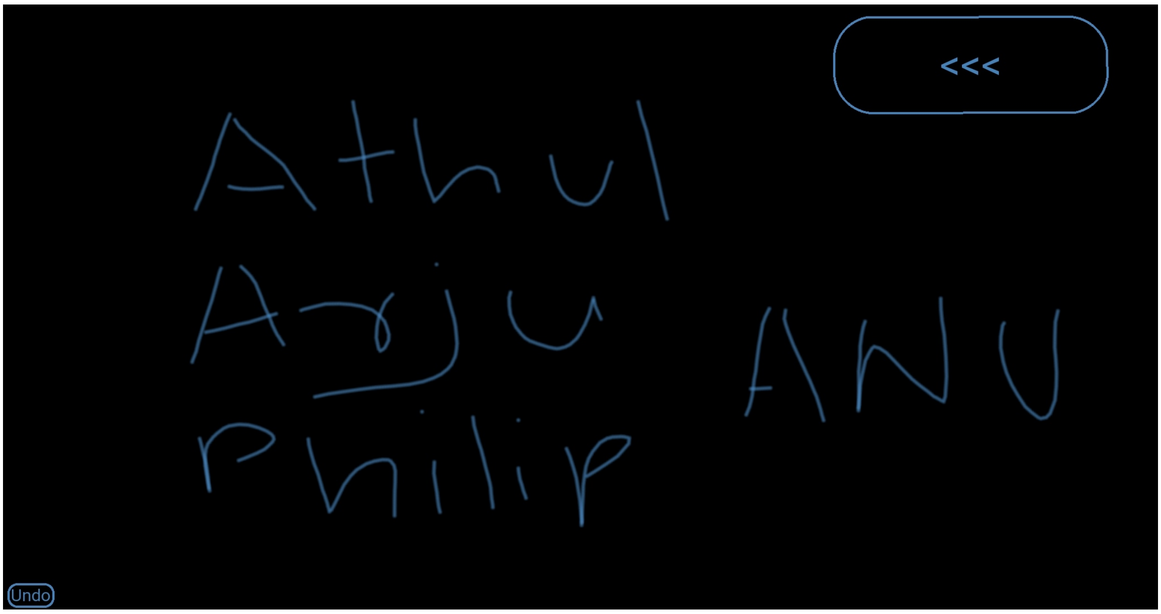

Figure 5.6: **Paint of AWT**

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

Augmented Wear Technology integrates digital information into the physical world and its objects, making the entire world your computer. It can turn any surface into a touch-screen for computing, controlled by simple hand gestures. It is not a technology which is aimed at changing human habits but causing computers and other machines to adapt to human needs.

6.2 FUTURE SCOPE

- To get rid of color markers
- To incorporate camera and projector inside mobile computing device.
- Whenever we place pendant- style wearable device on table, it should allow us to use the table as multi touch user interface.
- Applying this technology in various interest like gaming, education systems etc.
- To have 3D gesture tracking.
- To make sixth sense work as fifth sense for disabled person.

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